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P U B L I C A T I O N S

O F T H E

Astronomical Society of the Pacific.

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ADDRESS OF THE RETIRING PRESIDENT OF THE SOCIETY, AT THE SIXTH ANNUAL MEETING, MARCH 31, 1894.

By E. J. MOLERA.

Following the custom of the Society, I will give you an account of the state of affairs of the Association for the year terminating to-night, adding a brief synopsis of the principal astronomical events occurring during the same period.

At the beginning of the present year we had a total membership of 481 members, and 8 having been elected at our last meeting, we have at present 489 members, 61 of whom are life members. With a little effort on the part of each one of the members of the Society there is no reason why the membership should not increase considerably.

Our financial condition continues to be satisfactory, as the report of the Treasurer has shown to you.

At each of our meetings during the past year very valuable papers have been read, and the privileges granted to members by the LICK and CHABOT observatories, made them doubly interesting.

The *Publications* have kept the high standard that has characterized them from the beginning—the matter they contain, as well as their illustrations and printing, being of the best class. The thanks of the Society are due to the Publication Committee. All the other committees have also discharged the duties entrusted to them in a most satisfactory manner.

Owing to the financial depression prevailing everywhere in the United States, the San Francisco Observatory Committee

did not consider it opportune to ask for contributions to build an observatory on the site already granted in the Golden Gate Park. It is to be hoped that, during the coming year, financial circumstances will sufficiently improve for the committee to obtain the necessary funds. New and important observatories are being built constantly; San Francisco should not any longer remain without one.

I would recommend that the members of the Society should be asked to report to the Secretary what astronomical instruments they possess, and what is the special work they pursue, so that sections could be organized composed of such members as are working in the same field, who, by their mutual co-operation, would benefit one another, and through their reports serve the purposes of the Society. Our proximity to the LICK Observatory, and the interest the astronomers of that great institution take in our behalf, should not deter any of our members from contributing his quota of work and from reporting the same to the Society. We must always remember that ours is an association of amateur astronomers.

At our last annual meeting I had an opportunity to report to you the preparations made to observe the total eclipse of the Sun of April 16, 1893, in Chile, South America, by Professor SCHAEBERLE. The expenses of this expedition were paid by Mrs. PHŒBE HEARST, also one of our members. I have the pleasure to state, what you already know, that the expedition was completely successful. Professor SCHAEBERLE started alone, but on the day of the eclipse had the volunteer assistance of several amateur astronomers, among them Mr. WALTER GALE, of Sydney, another of the members of the Society. The weather continued to be propitious to him as in other expeditions, and he made the most of his opportunity. He obtained eight photographs, 18 x 22 inches, with the 40-feet photo-heliograph lens employed in a novel manner; eight photographs with the 6-feet telescope, and the same number with the 3-feet telescope. Astronomers agree in saying that never before have such fine photographs been obtained.* The eclipse was also observed by the Harvard College Observatory expedition, under Professor WILLIAM H. PICKERING, near the same locality in Chile. England sent two expeditions; one to Fundium, Africa, where

* The frontispiece of the present number is a reduced copy from one of them.

nine negatives were secured by Sergeant KEARNEY, R. E., and one to Para Curu, Brazil, where Mr. TAYLOR made twelve negatives—six without enlargement and six with the enlarging apparatus.

A French expedition, under the direction of M. DESLANDRES, went to Fundium, and another, under M. BIGOURDAN, went to Joel, Africa. All the expeditions had good weather and were successful in their observations.

The final results have not yet been worked out, but it can be predicted that the following facts will be established:

First—The coronal matter rotates with the Sun;

Second—There is no perceptible change in the form of the corona during the few minutes of duration of the eclipse in any one place;

Third—There is very little change, if any, in the form of the corona during the few hours' time in which the point of observation changes from one point to another on the earth.

It will be remembered that Professor SCHAEBERLE predicted the general shape of the corona, should his mechanical theory of that phenomenon be correct; of course, the nature of the problem allows only of a prediction involving the general outlines. Some of the observers have contended that the drawing published before the eclipse by Professor SCHAEBERLE, and the photographs taken by them at the time of the eclipse, do not correspond. Professor SCHAEBERLE, however, was stationed several thousand feet higher than any of the other observers, so that, aside from the advantages of the large scale of some of his inner corona-photographs, the remarkable purity of the atmosphere enabled him to photograph coronal outlines of apparently far greater extent than were obtained at lower altitudes. Contrary to the verbal reports so far published by some of the other observers, he finds that the equatorial extensions of the faint outer corona much exceeded the polar extensions.

As a result of certain studies given by these and other recent data, he has been led to the following conclusions pertaining to solar and cometary phenomena :

"First—According to mechanical principles, every incandescent liquid or gaseous body rotating in space must undergo periodical changes of—

(a) Internal pressure, and

(b) Varying surface strength in the form of zonal waves having

a general motion towards the equator of the rotating body. The alternate zones of strength and weakness form in the middle latitudes, but just before reaching the equator, the weaker zones become stronger, so that the zones of least strength are again found in a higher latitude.

Second—The variation of internal pressure is due to periodical inflow, chiefly at the equator, of cooled surface matter. The expansion of the cooled matter causes an increased pressure which in turn is made manifest in a series of eruptions which will not always be along the normals. Wherever the zone of least strength has a greater latitude than that of the submerged zone of greatest pressure, the streams of ejected matter will incline towards the nearer pole of the rotating body. When the conditions are the reverse, the inclination will be towards the equator.

Third—In all such bodies the angular velocity of the surface will vary, being least in the middle latitudes.

Fourth—These mechanical principles applied to our Sun, lead to a simple explanation of the observed facts regarding the formation, motion and periodicity of the Sun spots.

The structure of coronal matter observed during the last total eclipse of the Sun plainly indicates that this matter is apparently ejected from the Sun's interior with great velocity and is subject to the force of gravitation. By far the greater portion of the ejected matter seems to come from the Sun's spot-zone region.

Many observations go to show, and some prove, that much of the ejected matter forming the corona is carried to the very confines of the solar system. Some of this matter is captured by the Earth (and by the other larger bodies of the solar system) which thus becomes the center of certain cosmic phenomena usually attributed to purely inductive forces emanating from the Sun, but here claimed to be due to the actual transference of ponderable matter from the Sun to the Earth.

Evidently a very volatile body with very small mass will have an extensive atmosphere when heated. Such an atmosphere in space will retard the velocity of a coronal stream, the diminution of the velocity will be accompanied by an increase in density of the coronal matter even to the extent of again rendering it visible at great distances from the Sun."

The solar corona is without doubt the most imposing spectacle

in the sky. The desire to explain its cause has originated the wish of studying it without an eclipse. Professor HALE has brought to a greater degree of perfection his spectro-heliograph, which is an instrument used to photograph the Sun by monochromatic light. Professor YOUNG, Dr. BRAUN, Dr. LÖHSE, Dr. ZENGER, M. JANSSEN, M. DESLANDRES and others have tried, with variable success, to photograph the solar prominences. An attempt to obtain photographs of the corona on top of Pike's Peak, last summer, was unsuccessful. It is to be hoped that the progress made in photography and mechanical ingenuity will solve this most important problem and elucidate the observed phenomena of the Sun.

The year just past has been prolific in Sun spots, some of them, in dimension and shape, being remarkable. At the exhibit of the LICK Observatory at the Midwinter Fair in San Francisco, photographs of the magnificent Sun spot of last August and September can be seen. Sun spots were prominent January 21, February 5 and 25, with opera-glasses. In March a large and singular spot was added; in April new ones came; on August 9 there was a cluster visible with the naked eye. December 7 and 8 several could be seen with a field-glass. The theory of Sun spots, the period of their appearances, their connection with the form of the corona and the magnetic disturbances observed on the Earth, has occupied the minds of many astronomers during the present year. Their views have been abundantly explained in contributions to the astronomical publications.

Three unexpected comets appeared last year:

In January, 1893, the HOLMES' comet suddenly increased in size, becoming diffused, and the phenomenon was simultaneously observed by Dr. BARNARD at the LICK Observatory and by Dr. PALISA at Vienna. According to Dr. BARNARD, this comet was certainly a most remarkable one in many respects.

Comet *b*, 1893, was notable for its discovery being made by many amateur astronomers, with few days' difference.

Mr. W. E. SPERRA of Randolph, O., observed a comet, which he supposed to be FINLAY's, from June 20 onwards, but he did not communicate the fact to anyone in the usual way. This was, however, the new comet. Sr. ROSO DE LUNA of Logrosan, Spain, saw the comet on the night of July 4, and immediately sent a description of it to the director of the Observatory at

Madrid; the latter published a note giving an account of the discovery. Sr. Roso supposed the object to be a new star.

Messrs. JOHNSON and MILLER seem to have seen the comet at about 8^h 30^m P. M. of July 8; Mr. ALFRED RORDAME saw it July 8, at 10^h P. M., and immediately communicated the fact by telegraph to Dr. SWIFT of Rochester. On July 9, M. QUENISSET of the Juvisy Observatory, France, Mr. FILMER of Faversham, Kent, England, Professor Boss of Albany, and others, saw it at about the same time.

As you have seen by the report of the Committee on the Comet-Medal it has been decided not to make any award for the discovery of Comet *b*, 1893.

Professor KEELER of the Allegheny Observatory made many observations and took several spectrum photographs of this comet. During the period of the comet's greatest brightness Professor HUSSEY took several very fine photographs with the CROCKER telescope at the LICK Observatory. Professor CAMPBELL has made numerous observations, both visually and by photographic means. According to him, the comet's spectrum gives bands and lines in the carbon and cyanogen spectra.

Dr. KAYSER has made elaborate studies of the carbon bands in the electric arc, and comparisons with the spectrum of this comet. Several other astronomers have made also valuable observations of Comet *b*.

On October 16, 1893, Comet *c*, 1893, was discovered by BROOKS, who has discovered so many others. It was photographed by that renowned astronomer, Dr. E. E. BARNARD, at different times from October 18 to November 19. The photographs are excellent. They give a complete history of the extraordinary physical changes in this comet. One of these photographs, taken on the morning of November 14, shows the trail of a magnificent meteor, which shot across the sky in the region of the comet during the exposure.

This photograph exhibits such wonderful transformations of the comet, that one is inclined to believe that about October 21 it must have come in contact with some extraneous influence that shattered and disturbed its tail to a remarkable degree.

Mr. CAMPBELL has analyzed this comet and given an account of his work in our *Publications*. Bright bands are yielded by incandescent gases which surround the nucleus and form the

head of the comet. During this year Professor SCHAEBERLE announced his theory of the mechanical origin of the phenomena observed in comets, which is one of the most interesting contributions to astronomical science.

Comparatively few observations of the planets have been published during the year, the few made having been confined mainly to *Jupiter*, probably due to the attention called by the brilliant discovery of Dr. BARNARD the year previous.

The fifth satellite of *Jupiter* has been carefully and extensively observed by him at every opportunity. The final period of this satellite will not differ more than a few hundredths of a second of time from $11^{\text{h}} 57^{\text{m}} 22.6^{\text{s}}$. He has also made a careful re-determination of the diameters of *Jupiter* and its polar compression with the filar micrometer of the 36-inch equatorial. The resultant values are :

Equatorial diameter, 90194 ± 56 miles.

Polar diameter, 84566 ± 75 miles.

And a polar compression of $\frac{1}{15.99}$.

The equatorial diameter was measured on 34 nights and the polar on 24 nights. The other great feature observed is the gradual fading out of its prominent red spot.

Professor WILLIAM H. PICKERING's remarkable observations of the varying shapes of the satellites made in Arequipa need confirmation. If they prove to be correct, they will materially change our ideas of the physical constitution of these satellites.

Mars has been in an unfavorable position for observations ; some results from observations made in 1892 by HOLDEN, SCHAEBERLE, BARNARD, CAMPBELL, HUSSEY and others have been published during the year. I call your attention to the fine plates of *Mars* in our *Publications* and to the splendid photographs exhibited by the LICK Observatory at the Midwinter Fair.

MM. QUÉNISSET and RUDEUX, Mr. MEE and Dr. BARNARD have made interesting observations of *Saturn*. M. QUÉNISSET gives the results of his micrometric measures :

- (1). The polar compression of the planet is between $\frac{1}{8}$ and $\frac{1}{10}$.
- (2). The globe is not exactly at the centre of its system of rings.

Thirty-four minor planets were discovered during the year, bringing the total number to 380. Dr. BARNARD undertook to measure the diameters of the brighter asteroids with the 36-inch

telescope. This is a work that has never been successfully accomplished with smaller instruments, and a knowledge of their diameters has been mere guess work heretofore. Following are his results up to the present time :

Ceres — 599 ± 29 miles in diameter,

Pallas — 273 ± 12 miles in diameter,

Vesta — 237 ± 15 miles in diameter.

The November meteors were far more abundant this year, according to Dr. BARNARD, than in any other previous year observed by him. Especially were they plentiful on the mornings of November 13, 14 and 15. One nearly as large as the full Moon burst on the morning of the 14th just below *Coma Berenices*. Another meteor from *Leo* shot across the sky and burst between *Zeta* and *Eta Ursa Majoris*. It left a persistent train 10° long which remained bright and straight for about five minutes.

Few new observations of the Moon have been reported, excepting those in connection with the total eclipse of the Sun of April 16 and the annular eclipse of October 9.

The Moon, however, being the nearest astronomical body to us, has the greatest interest to all astronomers, who at all times study its structure and apparent topography. It has been desired to have a good map of the Moon for a great many years. Dr. LANGLEY, in 1890, addressed a circular to many public and private observatories regarding the making of a photographic map. From the advances made in photography it would seem that such a map would be comparatively easy to be produced, the only matter to be agreed upon would be its scale. The LICK Observatory has produced excellent negatives of the Moon with its great 36-inch refractor. These negatives, taken by Professor HOLDEN and Mr. COLTON, have been very successfully enlarged by Baron ALBERT VON ROTHSCHILD, of Vienna, Mr. NIELSEN, of Copenhagen, Professor WIENEK and Dr. SPITALER, of Prague. The beautiful enlargements by ROTHSCHILD are 80 inches to the Moon's diameter; in Professor WEINEK's latest results the Moon's diameter is about 10 feet.

A great deal has been said about the utility of enlarging photographs. There cannot be brought in the enlargement any feature that was not originally in the negatives, of course. The contrast between the light and the shadows is inversely propor-

tional to the square of the enlargement which places a limit to the amount of the enlargement that a negative is susceptible to sustain. Another disadvantage in photographic enlargements is that the molecules of silver are not precipitated uniformly in the vehicle in which they are suspended, so that, when an enlargement is carried too far, instead of having compact masses of pigment, there are to be seen black masses of grains, and when fine lines exist in the originals they become very indistinct, and sometimes disappear. The last objection is the greater, but a study of the different salts of silver available for photographic purposes, and their vehicles, might lead to processes of manufacture by which this hindrance could be removed. It seems that the quicker the action of an ordinary commercial photographic dry plate or its sensitiveness, the coarser is its grain. An albumen plate sensitized with nitrate of silver is hundreds of times less sensitive than one of gelatine sensitized with bromide of the same salt; but, on the other hand, the former will allow an enlargement one hundred times greater.

For photographs of the Sun, I believe that the albumen and TAUPENOT processes of photography would give wonderful results.

However, even with the existing processes, the experiments of Baron ALBERT VON ROTHSCHILD and of Professor WEINEK have shown that an atlas on a scale of 6 feet, or even 10 feet, to the Moon's diameter, can be produced. The utility of such atlases can hardly be disputed, they would give the means of convenient examination and comparison that are so essential in order to obtain general laws and features.

Leaving the planetary system, of which our own Earth is a modest member, there is nothing, perhaps, more interesting than the *Novæ*. They are near the beginning of the line of the nebular and stellar evolution. On October 26, a new star in *Norma* was discovered by Mrs. FLEMING on a photographic plate taken at the station of the Harvard College Observatory in South America.

It is remarkable that two new stars should have been discovered in the short interval of time of their appearances, when we consider the fact that only about twelve are known to have been observed since we have had astronomical records.

This new star has great importance, inasmuch as it will confirm or disprove the theories advanced to explain their existence.

At the first appearance of the *Nova Aurigæ*, it was supposed that the collision of one or more meteorites caused the sudden appearance of the lighted body in the firmament; many objections to that supposition led many to suppose that the collision took place in a grazing way.

As I pointed out to you last year, few heavenly phenomena had attracted so much attention as the *Nova Aurigæ*. Suffice to mention that amongst the astronomers who have observed and studied the new star, are BARNARD, BURNHAM, BECKER, BÉLOPOLSKY, CAMPBELL, CREW, COPELAND, Dr. and Mrs. HUGGINS, LOCKYER, MAUNDER, PICKERING, VON GOTTHARD, KONKOLY, VOGEL, SIDGREAVES, WOLF, YOUNG, and others. Professor CAMPBELL has made a particular study of this kind of heavenly bodies.

The following are some of the conclusions arrived at in regard to the new stars :

(1) It is doubtful whether the new stars are composed of one body or a system of several bodies.

(2) They are of constantly changing brilliancy, for instance, the *Nova Aurigæ*, after being first discovered by Dr. ANDERSON February 1, 1892, remained bright during February and March and passed beyond the power of the 36-inch telescope in April; in August it was found again, but it had become a star whose spectrum was nebular.

(3) In July, 1893, the *Nova Normæ* showed a spectrum of bright and dark lines exactly like the *Nova* of 1892 in February; but when its spectrum was observed at the LICK Observatory in February last it was found to have turned into a nebula !

(4) The fact that the new star of 1892 in *Auriga* and the new star of 1893 in *Norma*, and in all probability the new star in *Cygnus* in 1876 have run through identical courses, seems to establish their similarity of evolution.

Mr. CAMPBELL'S ideas were opposed at first by many astronomers. They however were based on numerous and well-taken observations. The final success of them points out how much better it is to make many observations and few theories, than few observations and many theories.

Dr. E. E. BARNARD has continued during the year his remarkable observations of *Nebulæ* and has taken many excellent photographs. His former achievements in photography of the Milky Way will give you an idea of the excellence of his work.

It is with great satisfaction that I record among the pleasant events of the year, that the degree of Doctor in Sciences was conferred upon him by the VANDERBILT University, Nashville, Tenn., on March 8, 1893, and together with Professor HALL was honored with the *Arago* medal, never conferred before but once.

Equally valuable observations and photographs of the spectra of different nebulae were taken during the last year by Professor CAMPBELL.

The photographic chart of the heavens is progressing favorably. Methods are already being devised to use the plates for the construction of a catalogue in the near future. The chart itself will be constructed later on. The observatories of the United States of America have not joined in this work, the reason probably being that the representatives of the United States and at least one of Germany preferred telescopes capable of covering at one exposure 25 square degrees (like the BRUCE telescope of Harvard College Observatory), instead of telescopes covering only 4 square degrees, which were adopted by the commission. It will take 11,000 plates to cover the heavens according to the plan of the International Congress, whereas 1600 plates would suffice had the telescopes been constructed on the formula of a portrait-lens.

Miss BRUCE has presented to Harvard College a photo-telescope capable of performing the work as proposed by the American astronomers, and it is confidently expected that two observatories, with as many astronomers using this telescope, will do the work as completely and possibly as quickly as eighteen astronomers with as many telescopes of the form adopted by the Paris Conference. One good result from that disagreement will be the emulation among the astronomers and the duplication of results.

The BRUCE telescope will be used by the PICKERINGS at the Cambridge Observatory and afterwards in Arequipa, South America.

Besides the remarkable work in practical astronomy, this last year has witnessed many other notable events in astronomy.

The Chicago International Exhibition brought together many excellent exhibits of observatory work. On account of the International Congress of Astronomers, some distinguished astronomers were also brought together, and during their sessions read some very interesting papers and promoted lucid and instructive discussions. Another International Congress was projected by the

managers of the Midwinter Fair in this city. Circulars were sent inviting prominent astronomers all over the world, but few accepted the invitation and, on that account, the idea of convening another congress has been abandoned.

I recommend every resident member of this Society to visit the excellent exhibit at the Midwinter Fair of the University of California and examine carefully the astronomical photographs furnished by the Harvard College and the LICK Observatories. It would be impossible for me to describe to you all that is there exhibited. The Harvard and Arequipa Observatories, besides beautiful views of their own respective observatories and educational objects, show fine views of the Southern Cross, of the solar corona, nebula, comets, the Moon, etc. A very remarkable photo-map of the solar spectrum made by Professor ROWLAND, with his concave grating, forms the most interesting feature of the admirable exhibit of the JOHN HOPKINS University.

The collection of the LICK Observatory is most complete, comprising over 150 positives on glass of the most interesting celestial objects, among which I may mention: The large 18 x 22 images of the corona of 1893 by SCHAEBERLE; the beautiful one of 1889 made by BARNARD; the *Nova* by SCHAEBERLE and CAMPBELL; Sun spots by PERRINE; different planets and clusters by HOLDEN, HUSSEY and CAMPBELL; the beautiful Moon photographs taken with the large equatorial, and the splendid photographs of the Milky Way and nebula by BARNARD; landscapes and other plates by Mr. COLTON. Amongst the photo-prints, those of Professor WEINEK, of Prague, are especially remarkable, and the enlargements made by Baron von ROTHSCHILD of LICK Observatory negatives of the Moon, by the carbon process, are without rival for their beauty.

That interest in astronomical science has not diminished is shown by the grants made of instruments which have been recorded this year. One of the most attractive exhibits at the World's (Chicago) Exposition was the YERKES refractor, soon to be finished, with an aperture of 40 inches. The photo-telescope, donated by Miss BRUCE, the largest of its kind, is another example, as well as other telescopes like the 20-inch for Manila, Phillipine Islands, and the Meudon telescope, of an aperture of 32.3 inches.

The wonders that a single year brings to the contemplation of man are truly great, and yet improved instruments and methods,

and increased observers all over the world, will eclipse what is done at the present time. What SPENSER said with true prophetic inspiration, in the sixteenth century, can be repeated to-day:

"Yet all these were, when no man did them know,
 Yet have from wisest ages hidden been:
And later times things more unknowne shall show.
 Why then should witlesse man so much misweene,
 That nothing is but that which he hath seen?
What if within the Moone's fayre shining sphere,
 What if in every other starre unseene
Of other worlds he happily should heare,
 He wonder would much more: yet such to some appeare."

THE CHABOT OBSERVATORY.

BY CHAS. BURCKHALTER.

A prominent feature of the Oakland School Department is the CHABOT Observatory, the only Observatory of its kind in the world. It was founded by a public-spirited citizen of Oakland, the late ANTHONY CHABOT, Esq., and presented to the Board of Education in trust for the city of Oakland, to be used to educate the general public and the pupils of our public schools.

The original building was erected in 1883, under the direction of Hon. J. C. GILSON, who was Superintendent of Schools at the time, and Hon. WM. H. JORDAN, member of the Board of Education, and it was due to the influence of these gentlemen that Mr. CHABOT was induced to build and equip the Observatory, and the school children of Oakland will always owe them a debt of gratitude.

About one year ago the Observatory was almost entirely reconstructed, and bears no resemblance to the old building. (See cut.)

The former building consisted essentially of a transit room, reception room and the equatorial room (14 feet in diameter) at the top of the tower, and it was reached by 4 flights of zigzag stairs of 52 steps, the entrance being through a trap-door in the floor—a most awkward arrangement. Of the old building, the